MIE 100S : Dynamics

Two Components :

(i) **Kinematics**

x
v
a
t

$a = \frac{dv}{dt}$ $\quad x = x_0 + v_0 t + \frac{1}{2} a t^2$

(ii) **Kinetics**

forces
moments (torques)

$\vec{F} = m\vec{a}$

Course Syllabus

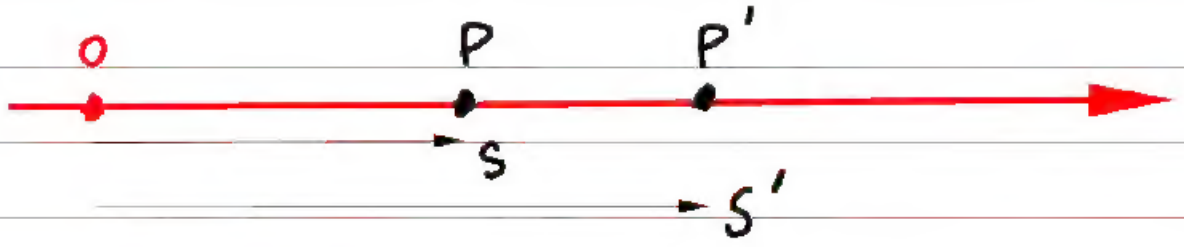
Meriam & Kraige – Chapter 1

General intro to Dynamics — Read

Chapter 2/1, 2/2: Rectilinear Motion

(i.e., Motion along a straight line)

Need: Axis
Origin
+/− Direction



position s has units (metres), +/− sign

Δs = displacement = $s' - s$ (+ve or -ve)

$$\text{velocity } v = \frac{ds}{dt}$$

(velocity is a vector, but for rectilinear motion it reduces to a scalar with +/− sign)

speed $= |v| = \left|\frac{ds}{dt}\right| = |\dot{s}|$ (always + ve)

$$\text{acceleration } a = \frac{dv}{dt} = \frac{d^2s}{dt^2} = \ddot{s}$$

Average velocity $= \int_{\tilde{j}} v\,dt \,/\, \tilde{j} = \frac{\Delta s}{\tilde{j}}$

Average speed $= \int_{\tilde{j}} |v|\,dt/\tilde{j} = \int_{\tilde{j}} \left|\frac{ds}{dt}\right| dt/\tilde{j}$

Note: Average speed $\neq$ |Average Velocity|

Eg: Consider round-trip Toronto → Ottawa → Toronto
car travels at 100 km/hr

average speed = ? **average velocity** = ?

Engineering Applications

acceleration is a function of

(i) time
(ii) position
(iii) velocity

Can we find expressions for velocity and position for these 3 cases?

(i) $a = a(t)$

but $a(t) = \frac{dv}{dt}$ → $a(t)\,dt = dv$

→ $$v = v_0 + \int_0^t a(t')\,dt' \qquad *$$

$v = v_0 + a_0 t$ if acceleration is constant a_0

Also $\frac{ds}{dt} = v$ → $\int_{s_0}^{s} ds' = \int_{t_0}^{t} v\,dt'$

Substitute from * $s - s_0 = \int_0^t \left[v_0 + \int_0^{t'} a(t'')\,dt'' \right] dt'$

→ $$s = s_0 + v_0 t + \int_0^t \left[\int_0^{t'} a(t'')\,dt'' \right] dt'$$

We need to know the function $a(t)$ in order to go any further.

E.g. If $a(t) = a_0$

$s = s_0 + v_0 t + \frac{1}{2} a_0 t^2$ if $a(t) = a_0$

Key points from Lecture #1

(i) Kinematics & kinetics

- we begin with rectilinear kinematics

(ii) $v = \frac{ds}{dt}$, $a = \frac{dv}{dt} = \dot{v}$

$$v = v_0 + \int_0^t a(t')dt' \qquad s = s_0 + v_0 t + \int_0^t \left[\int_0^{t'} a(t'')dt'' \right] dt'$$

Looking ahead to lecture #2:

Rectilinear motion with

$a = a(s)$; $a = a(v)$

Your List of Things to do

(i) Review syllabus

(ii) Read Meriam 1, 2/2

Organizational / Administrative Questions?

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